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| TUNG & ASSOCIATES Suite 120 838 W. Long Lake Road Bloomfield Hills, MI 48302 | | | | |
| | | | EXAMINER RUGGLES, JOHN S | |
| | | | ART UNIT 1756 | PAPER NUMBER |

DATE MAILED: 04/06/2004

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary

Application No.

10/051,906

Applicant(s)

SU ET AL.

Examiner

John Ruggles

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-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
 - If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
 - If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
 - Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 26 January 2004.
- 2a) ☒ This action is **FINAL**. 2b) ☐ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1-4, 8, 10-19 and 21-24 is/are pending in the application.
- 4a) Of the above claim(s) _____ is/are withdrawn from consideration.
- 5) ☐ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) 1-4, 8, 10-19 and 21-24 is/are rejected.
- 7) ☒ Claim(s) 1-4, 8, 10-19 and 21-24 is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☒ The specification is objected to by the Examiner.
- 10) ☒ The drawing(s) filed on 26 January 2004 is/are: a) ☒ accepted or b) ☐ objected to by the Examiner.
- Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
- Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some * c) ☐ None of:
- ☐ Certified copies of the priority documents have been received.
 - ☐ Certified copies of the priority documents have been received in Application No. _____.
 - ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

- ☐ Notice of References Cited (PTO-892)
- ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
- ☐ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08)
Paper No(s)/Mail Date _____
- ☐ Interview Summary (PTO-413)
Paper No(s)/Mail Date _____
- ☐ Notice of Informal Patent Application (PTO-152)
- ☐ Other: _____

DETAILED ACTION

This Office action is in response to amendments and accompanying remarks filed on 26 January 2004. Claims 1, 4, 8, 11, 14, 16, and 18-19 have been amended, claims 5-7, 9, and 20 have been cancelled, and new claims 21-24 have been added. Therefore, only claims 1-4, 8, 10-19, and 21-24 remain under consideration.

Drawings

The previous objections to the drawings based on mislabeling in the original versions of Figures 2C and 2D have been overcome by the proposed "mark up copy" received on 26 January 2004 for sheet 2 of the 3 original sheets of drawings, because this proposed copy of sheet 2 includes corrected versions of these figures. Therefore, the previous objections are now withdrawn in view of this proposed drawing correction. A clean replacement copy of this corrected drawing is required in response to this Office action.

Specification

Applicants have corrected the previous specifically exemplified objections to the original specification, along with a few more, to improve readability of the specification. The corrections to overcome these previous objections are appreciated and all of the proposed corrections are accepted, but other portions of the specification still need further revision for at least the reasons set forth below.

35 U.S.C. 112, first paragraph, requires the specification to be written in "full, clear, concise, and exact terms." The specification is still replete with terms, which are not clear,

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concise and exact. The specification should again be revised carefully in order to comply with 35 U.S.C. 112, first paragraph. Examples of some unclear, inexact or verbose terms used in the specification are: (1) in line 10 of paragraph 008 on page 7, "for example, the passivation layer" should be changed to --for example, to the passivation layer--, to be grammatically correct; (2) in line 3 of paragraph 0026 on page 14, "the protective according" must be corrected to --the protective layer according--, also to be grammatically correct; (3) in lines 16-17 of paragraph 0028 on page 16, "photoresist layer 14B" must be corrected to --photoresist layer 24B--, in order to correspond to Figure 2C, as described in this passage; and (4) in line 3 of paragraph 0034 on page 19, --stripping-- has been misspelled. Note that due to the number of errors, those listed here are merely examples of the corrections needed and do not represent an exhaustive list thereof.

Appropriate correction is required. An amendment filed making all appropriate corrections must be accompanied by a statement that the amendment contains no new matter and also by a brief description specifically pointing out which portion of the original specification provides support for each of these corrections.

Claim Objections

Claims 1-4, 8, 10-19, and 21-24 are now objected to because of the following informalities: (1) in claim 1 at line 15, "on protective layer" should be corrected to --on the protective layer--, if this phrase was intended to be in reference to the same protective layer as recited at line 8 of this claim and (2) in claim 11 at line 16, "forming an opening" should be changed to --and forming an opening in the photoresist layer--, if this is the meaning intended in

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accordance with the original disclosure. Claims 2-4, 8, 10, and 21-22 are dependent on claim 1 and claims 12-19 and 23-24 are dependent on claim 11. Appropriate correction is required.

These new objections have been necessitated by amendment.

Claim Rejections - 35 USC § 112

The following is a quotation of the first paragraph of 35 U.S.C. 112:

The specification shall contain a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make and use the same and shall set forth the best mode contemplated by the inventor of carrying out his invention.

Claims 1-4, 8, 10, and 21-22 are rejected under 35 U.S.C. 112, first paragraph, as failing to comply with the written description requirement. The claim(s) contains subject matter, which was not described in the specification in such a way as to reasonably convey to one skilled in the relevant art that the inventor(s), at the time the application was filed, had possession of the claimed invention.

In currently amended claim 1 at lines 6 and 9-10, the phrase "uppermost passivation layer" does not find specific support in the specification as originally filed. While a single "passivation layer 22" is described in line 12 of paragraph 0027 on instant page 15, this single layer does not provide sufficient basis for the newly recited "uppermost passivation layer". In fact, Figure 2A shows the passivation layer 22 as underlying an under bump metallization layer 24A. While it remains unclear where applicants find support for this newly added phrase, for the purpose of this Office action, "uppermost passivation layer" has been interpreted in light of the disclosure to simply mean --passivation layer--.

Also, in currently amended claim 1 at lines 15-16, applicants have added the phrase “comprising an opening overlying the UBM contact layer” directly after the original phrase “protective layer”. This choice of wording suggests that the protective layer 24C must have already had an opening over the UBM contact layer 24A at the time the patterned photoresist layer 26 was formed, but this meaning is not supported by the original disclosure as shown in Figures 2E and 2F. Instead, these figures show that the opening in the protective layer 24C was formed by ashing or etching of the protective layer 24C *after* formation of the patterned photoresist layer 26 (functioning as an etching mask), as described in paragraph 0031 on pages 18-19. Applicants may have meant to recite that the patterned photoresist layer 26 was formed to have an opening overlying the UBM contact layer 24A and that this photoresist layer 26 was formed on the protective layer 24C, which is the interpretation of this phrase used for the purpose of this Office action.

In summary, applicants are required to state for the record what specific portions of the original specification provide support for each of these newly recited phrases, if such support exists. Nevertheless, for the purpose of this Office action and in order to expedite prosecution of this application, (1) the phrase “uppermost passivation layer” has been interpreted in light of the disclosure to simply mean --passivation layer-- and (2) the phrase “forming a patterned photoresist layer on protective layer comprising an opening overlying the UBM contact layer” has been interpreted to mean --forming a patterned photoresist layer comprising an opening overlying the UBM layer, the patterned photoresist layer being formed on the protective layer--.

However, applicants must still amend at least claim 1 in response to this rejection. Claims 2-4,

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8, 10, and 21-22 are dependent on claim 1. This new rejection has been necessitated by amendment.

The following is a quotation of the second paragraph of 35 U.S.C. 112:

The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

Claim 16 is rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.

Claim 16 lacks antecedent basis for the phrase "the UBM layers". This new rejection has been necessitated by amendment.

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

Claims 1-4, 8, 10-19, and 21-24 are rejected under 35 U.S.C. 103(a) as being unpatentable over Costas, et al. (US Patent 6,137,125) in view of admitted prior art and further in view of Lee (US Patent 6,410,414).

Costas teaches a monolithic microwave integrated circuit (MMIC) and a process of making it, including flip-chip mounting of the MMIC (column 1, lines 6-8). The process involves spin coating, then patterning (by imaging and rinsing with a developer solvent, which encompasses wet chemical stripping) and curing of a benzocyclobutene (BCB) low dielectric film 10 on a processed MMIC wafer 1, as shown in Figures 2-3 (column 3, lines 34-54). Figure 4 shows overcoating with ceramic 401 (preferably silicon carbide (SiC) or silicon nitride) and Figure 5 shows reactive ion etching (RIE) of the ceramic 401, along with those portions of the remaining underlying BCB 10 on bond pads 6, through a patterned resist mask to open up underlying bond pads 6 and streets 5 of the MMIC wafer 1 (column 3, lines 54-66). Then, Figure 6 shows formation of solder bumps 601 on the bond pads 6 by either electroplating or evaporation through openings in the patterned ceramic 401 and BCB low dielectric film 10, both of these methods are well known to one of ordinary skill in the art (column 3, line 66 to column 4, line 2 and column 5, lines 25-26, this is equivalent to forming of solder columns through a patterned resist stencil either (1) of photosensitive BCB or (2) with underlying non-photosensitive BCB, which has been patterned through the resist stencil). The BCB low dielectric polymer 10 possesses mechanical, electrical, and chemical properties that make it compatible with MMIC fabrication (column 4, lines 8-10). Also, while the BCB low dielectric polymer 10 is preferably photosensitive to simplify photolithographic patterning of the BCB (column 4, lines 12-14), this is not required as indicated by a comparison of Figures 4 and 5, which show removal of BCB 10 over the bond pads 6 along with RIE of overlying ceramic 401 through a patterned resist. This clearly suggests that non-photosensitive BCB could also have been patterned by RIE through an overlying patterned resist layer, either as a separate etching

step or together with etching of another layer, as shown. Other advantages of using BCB are that it provides sufficient resistance to moisture, which is increased by addition of an overlying patterned ceramic layer (e.g., SiC, etc.) and that it also provides excellent resistance to mechanical damage during subsequent processing, particularly during final assembly (column 4, lines 27-34, which is understood to include solder reflow for bonding of metal connections).

Costas does not specifically teach (1) the glass transition temperature (T_g) of the BCB low dielectric polymer protective layer, (2) thermal treatment for reflow of the solder bumps to form solder balls, (3) the composition of the solder used, (4) what metal(s) are included in the bond pads, or (5) RIE of the metal bond pads to reveal surrounding portions of an underlying passivation layer.

However, applicants have already admitted in instant Figures 1A-1E as described in instant paragraphs 006-007 on instant pages 4-7 that the following teachings were already known *prior art* at the time the instant invention was made: [a] forming a bonding pad 10 (e.g., Cu, Al, etc.) by vapor deposition on a semiconductor wafer 8, patterning a passivation layer 12 (e.g., SiN, SiO₂, etc.) overlying edge portions of the bonding pad 10 and adjacent areas of the substrate semiconductor wafer 8, covering with one or more under bump metallization (UBM) layers 14A (e.g., Ti, etc.) over the bonding pad 10 as shown in Figure 1A, patterning resist 16 having an opening 17 over the UBM layer(s) 14A on the bond pad 10 as shown in Figure 1B, forming additional UBM layers 14B (e.g., Cu, etc.) and 14C (e.g., Ni, etc.) over 14A in the opening 17 (4), depositing solder 18A in opening 17 by either separate layers (e.g., Pb then Sn, etc.) followed by reflow to make them homogeneous as shown in Figure 1C or depositing homogeneous solder (by e.g., electroplating, vapor deposition, etc.), removal of resist 16, RIE of

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exposed UBM layer(s) down to passivation layer 12 as shown in Figure 1D (5), and then reflow of the solder 18A to form solder bump or ball 18B as shown in Figure 1E (2); and [b] using a high lead solder having a composition of 95% Pb/5% Sn (95 Pb/5 Sn) or 90 Pb/10 Sn (e.g., with melting temperatures in excess of 350 °C, etc.), which are reliable and particularly resistant to fatigue (3).

Lee shows a semiconductor device and a process of fabricating the semiconductor device, particularly relating to chip scale packaging that involves photolithographic patterning and subsequent forming of solder bumps or balls for attachment of external connectors or terminals (column 1, lines 6-9 and 51-54). The process includes forming a patterned benzocyclobutene (BCB) layer 112 on a metal pattern 110 and a passivation layer 108, leaving openings to expose portions of metal 110 that correspond to external terminal pads 118, as shown in Figure 3 (column 3, lines 40-44). The BCB 112 is patterned by known photolithography and etching, which encompasses etching through a patterned resist, to mask an area for connection of a solder ball to the exposed metal 110. The BCB has a glass transition temperature (T_g) of approximately 60 °C higher than 290 °C, which is the T_g of polyimide (or the T_g for BCB is about 350 °C, (1)). Thus, BCB is more stable in packaging processes performed at high temperatures (column 3, lines 45-60). Figure 4 shows subsequent reflow for attaching solder balls 114 to external terminal pads 118, which form external terminals for a chip scale package (CSP) suitable for mounting on a printed circuit board (column 3, lines 61-64). The inherent characteristics of BCB (e.g., low water intake, etc.) reduce defects caused by corrosion for enhancing reliability of the semiconductor package. Further, BCB has good high temperature stability to reduce damage

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during processing and low volatility to prevent corrosive byproducts during curing in order to allow stable overall fabrication (column 6, line 62 to column 7, line 5).

It would have been obvious to one of ordinary skill in the art at the time the invention was made to have conducted the photolithographic process of the instant claims in accordance with the known teachings of the admitted prior art as noted above along with patterning of a resist either (i) of or (ii) with BCB, as taught by Costas and shown by Lee, in which the BCB has a T_g of about 350 °C (an inherent property of BCB shown by Lee, instant claims 1-4, 10, and 22) to allow subsequent reflow of high lead solder bumps or balls (e.g., 95 Pb/5 Sn, 90 Pb/10 Sn, etc., instant claims 8, 11-19, 21, and 23-24) without damage during processing (due to the protection afforded by the BCB) for the reasons discussed above, including those shown by Lee. The inherent characteristics of BCB (e.g., low water intake, etc.) reduce defects caused by corrosion for enhancing reliability of the semiconductor package. Further, BCB has good high temperature stability to reduce damage during processing and low volatility to prevent corrosive byproducts during curing in order to allow stable overall fabrication. Lee shows both of these reasons. Other advantages of using BCB are that it provides sufficient resistance to moisture and that it also provides excellent resistance to mechanical damage during subsequent processing, particularly during final assembly (which is understood to include solder reflow for bonding of metal connections), as taught by Costas.

Response to Arguments

Applicant's arguments filed 26 January 2004 have been fully considered but they are not persuasive.

The previous objections to the drawings based on mislabeling in the original versions of Figures 2C and 2D have been overcome by the proposed "mark up copy" received on 26 January 2004. A clean replacement copy of this corrected drawing is required in response to this Office action.

Applicants have corrected the previous specifically exemplified objections to the original specification, along with a few more, but other portions of the specification still need further revision for at least the reasons set forth above.

Claims 1-4, 8, 10-19, and 21-24 are now objected to because of the informalities pointed out above. These new objections have been necessitated by amendment.

Claims 1-4, 8, 10, and 21-22 are now rejected under the first paragraph of 35 U.S.C. 112 for the reasons set forth above. This new rejection has also been necessitated by amendment.

Claim 16 is now rejected under the second paragraph of 35 U.S.C. 112 for the reason set forth above. This new rejection has also been necessitated by amendment.

Applicants have stated on page 15 in the Remarks section of the amendment filed on 26 January 2004 that no new matter has been entered. Pages 15-16 set forth adequate support for most of the changes made in the currently amended claims. This effort is acknowledged and is greatly appreciated. However, other amendments made in the current versions of these claims appear to be reciting new phrases that do not find sufficient support in the original specification for the reasons pointed out above. Applicants are required to either (a) further state for the record what specific portions of the original specification provide support for each of the newly recited phrases pointed out above or (b) properly amend the claims to remove all such newly recited phrases, in order to more fully comply with the first paragraph of 35 U.S.C. 112.

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In response to applicants' argument on page 18 that Costas is nonanalogous art, it has been held that a prior art reference must either be in the field of applicant's endeavor or, if not, then be reasonably pertinent to the particular problem with which the applicant was concerned, in order to be relied upon as a basis for rejection of the claimed invention. See *In re Oetiker*, 977 F.2d 1443, 24 USPQ2d 1443 (Fed. Cir. 1992). In this case, Costas is viewed to be in the field of applicants' endeavor as analogous art. This is because Costas specifically recognized that BCB possesses properties that make it compatible with fabrication of an integrated circuit involving patterning and etching of the BCB and overlying ceramic through a patterned resist mask by etching the ceramic and underlying BCB to reveal underlying bond pads, then formation of solder bumps or columns through the BCB and overlying ceramic patterned via the resist pattern onto the underlying exposed areas of the bond pads. Other advantages of BCB recognized by Costas are that it provides resistance to moisture and excellent resistance to mechanical damage during subsequent processing, particularly during final assembly (which is understood to include subsequent solder reflow for bonding of metal connections).

In response to applicant's arguments against the references individually, one cannot show nonobviousness by attacking references individually where the rejections are based on combinations of references. See *In re Keller*, 642 F.2d 413, 208 USPQ 871 (CCPA 1981); *In re Merck & Co.*, 800 F.2d 1091, 231 USPQ 375 (Fed. Cir. 1986). Costas has not been applied alone, but rather in combination with applicants' admitted prior art and also with Lee. It is this combination of references that is shown to render the instant claims obvious to one of ordinary skill in the art for the reasons set forth above.

In response to applicants' argument that the examiner's conclusion of obviousness is based upon improper hindsight reasoning, it must be recognized that any judgment on obviousness is in a sense necessarily a reconstruction based upon hindsight reasoning. But so long as it takes into account only knowledge which was within the level of ordinary skill at the time the claimed invention was made, and does not include knowledge gleaned only from the applicants' disclosure, such a reconstruction is proper. See *In re McLaughlin*, 443 F.2d 1392, 170 USPQ 209 (CCPA 1971). Costas teaches the applicability of underlying BCB for a process involving subsequent solder bump or column formation as described above. The other components not specified by Costas have been set forth above and are restated below, itemized as (1-4).

Lee shows that BCB has an inherent glass transition temperature (T_g) of about 350 °C (1). Thus, BCB is more stable in packaging processes performed at high temperatures. This provides both the motivation to combine Lee with Costas and a reasonable expectation of success when using BCB in solder reflow packaging at high temperatures of about 350 °C, just as sought by applicants and in a similar manner. Applicants' admitted prior art is considered to be within the level of ordinary skill at the time the claimed invention was made and is therefore usable in combination with the other cited references. This admitted prior art teaches the remaining components not specified by Costas and Lee: (2) subsequent thermal treatment for reflow of the solder bumps to form solder balls; (3) using solder having a composition of 95% Pb/5% Sn (95 Pb/5 Sn) or 90 Pb/10 Sn (e.g., with melting temperatures in excess of 350 °C, etc.) as being reliable and particularly resistant to fatigue; (4) using UBM layer(s) of metal such as Cu or Ni on the bond pad; and (5) RIE of exposed UBM layer(s) down to an underlying passivation layer.

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For at least the above reasons, the instant claimed invention is still held to be obvious over the same prior art of record and the former art rejection of the instant claims has been maintained, revised only as necessitated by applicants' amendments to these instant claims.

Conclusion

Applicants' amendments necessitated the new ground(s) of objection and rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire **THREE MONTHS** from the mailing date of this action. In the event a first reply is filed within **TWO MONTHS** of the mailing date of this final action and the advisory action is not mailed until after the end of the **THREE-MONTH** shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than **SIX MONTHS** from the date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to John Ruggles whose telephone number is 571-272-1390. The examiner can normally be reached on Monday-Thursday and alternate Fridays.

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If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Mark Huff can be reached on 571-272-1385. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).



John Ruggles
Examiner
Art Unit 1756



JOHN A. MCPHERSON
PRIMARY EXAMINER